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PROCEEDINGS SERIES

# FOOD IRRADIATION PROCESSING

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## FREE RADICALS FORMATION AND DECAY IN IRRADIATED SPICES

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### INTRODUCTION

This investigation of free radicals produced in the continuous radiolysis of spices and vegetable seasonings was undertaken for two reasons. First, irradiation processing of spices and spiced meat products may result in the formation of long-lived free radicals. Secondly, such free radicals, irrespective of their lifetimes, are among the important precursors of final radiolytic products. The free radical intermediates produced by ionizing radiation may be observed using electron spin resonance techniques.

For this investigation, seeds of black pepper, sage leaves and onion as an illustration of bulbs in the form of powder or flakes were selected for the irradiation studies.

### METHOD

*Sample irradiation.* Samples were irradiated at controlled temperatures using a self-contained caesium-137 radiation source. This source currently has a strength of 147 000 Ci<sup>1</sup>. This radiation source was described previously<sup>2</sup>.

*Analytical measurement.* Measurements of radiation-generated free radicals were made on dry samples in an electron spin resonance spectrometer (Model E-109B, Varian Associates). The resonator of the spectrometer was thermostatically controlled to measure chemical changes in samples at temperatures between 77°K (–196°C) and room temperature.

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<sup>1</sup> 1 Ci =  $3.70 \times 10^{10}$  Bq.

<sup>2</sup> SHIEH, J.J., JENKINS, R.K., WIERBICKI, E., Dosimetry and dose distribution in caesium-137 irradiation unit at the Eastern Regional Research Center, Radiat. Phys. Chem. (in press).

## POSTER PRESENTATIONS

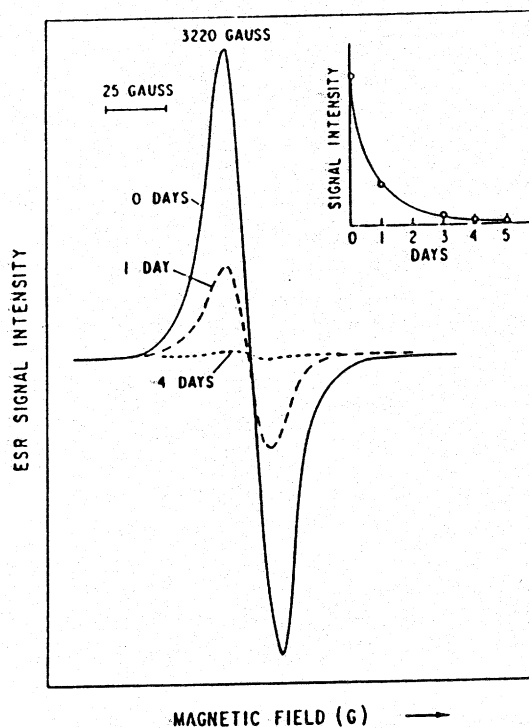


FIG.1. ESR spectra of dehydrated onions irradiated with  $^{137}\text{Cs}$  gamma rays to 30 kGy at 25°C showing the presence of free radicals after irradiation and their decay with storage time.

## RESULTS

Irradiation of black pepper, sage and dehydrated onions at dosages of 1, 3, 10 and 30 kGy at 25°C produced free radicals detectable in the electron spin resonance spectrometer. The initial singlet-like pattern, which was ascribed to a carbon-centred radical, diminished gradually in signal intensity without conversion to another type of free radical in the various spices. The ESR spectrum of irradiated dehydrated onions is characterized by a singlet-like pattern. Although the amount of free radicals produced was directly related to the irradiation dose, the free radicals were not long lived and decayed within 4 to 5 days at 25°C with a half-life of 0.45 days (Figs 1 and 2). A fairly small amount of endogenous stable free radicals (due to processing or something else) was observed in this investigation. Irradiation of sage and black pepper under identical conditions produced free radicals which decayed rapidly reaching background level within about 10 days (see Fig.3 and Table I).

# POSTER PRESENTATIONS

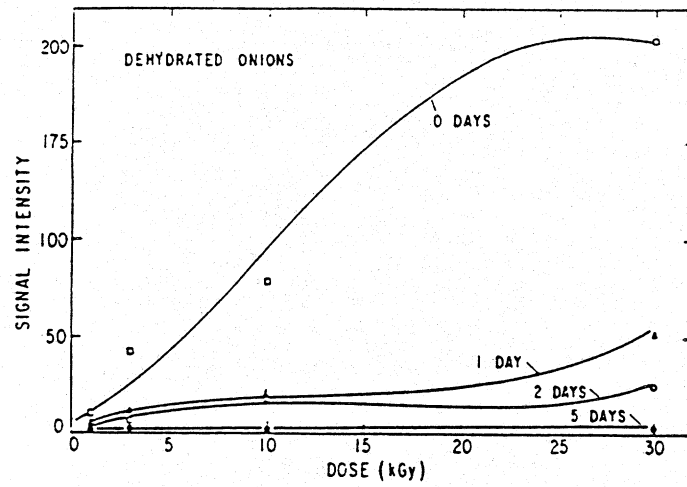


FIG.2. Effect of storage time on decay of free radicals generated by gamma irradiation. The dehydrated onions were irradiated at 25°C with 0.5, 1.0, 10 and 30 kGy and then stored.

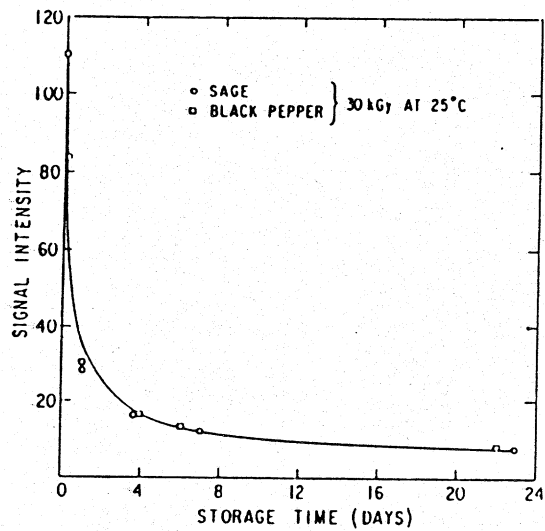


FIG.3. Decay of free radicals generated by gamma irradiation with storage time. Black pepper and sage were irradiated at 25°C with 30 kGy and then stored.

## POSTER PRESENTATIONS

TABLE I. ESR SIGNAL INTENSITY OF IRRADIATED SAGE

Dose (kGy)	Storage time (d)				
	0	1	2	10	24
1	5.3	3.6	3.3	2.0	2.0
3	31.5	19.0	8.5	4.5	2.9
10	54.5	27.0	22.0	11.5	6.5
30	84.0	28.8	22.0	7.5	6.4

*Note:* Intensity of 4.0 in non-irradiated sample was observed.

## CONCLUSION

The kinetic information obtained by monitoring the changes in the ESR signal at 25°C as a function of time, yielded some useful results. First, the initial singlet-like pattern in irradiated spices diminished gradually in signal intensity without conversion to another type of free radical. Secondly, the free radicals produced in the samples due to irradiation treatment did not persist but instead decayed, although a small amount of stable free radicals was observed in our samples.